

Material Selection and Shade Matching for a Single Central Incisor



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INTRODUCTION

With regard to esthetics, the single central incisor poses the greatest restorative challenge for the clinician; not surprisingly, it can also be the most difficult tooth for the dental technician to match. Selecting the shade of the restoration depends in part on the material used for the understructure, and there is a wide assortment available from which to choose. The following are among the most common:

An experienced technician can mask the underlying dark tooth color using porcelains with detailed color-masking techniques.

UNDERSTRUCTURE MATERIAL

- Zirconia (e.g., Procera® [Nobel Biocare; Yorba Linda, CA], Lava™ [3M ESPE, St. Paul, MN], Cercon® [Dentsply Int., York, PA], Everest™ [KaVo America Corp.; Lake Zurich, IL], In-Ceram® [Vident; Brea, CA])
 - Flexural strength: approximately 1,200 MPa
 - Translucency: very low
 - Opacity: high
- Alumina core or glass-infiltrated alumina (e.g., Procera, In-Ceram)
 - Flexural strength: 450 to 700 MPa
 - Translucency: low
 - Opacity: moderate

- Pressed Ceramics (leucite-reinforced or lithium-disilicate and apatite glass ceramics, e.g., Empress® [Ivoclar Vivadent; Amherst, NY], OPC® [Pentron; Wallingford, CT], Authentic® [Jensen Industries; North Haven, CT], GC Initial [GC America; Alsip, IL])
 - Flexural strength: 120 to 450 MPa
 - Translucency: high
 - Opacity: low
- Nonoxidizing metal (e.g., Captex™ [Captex; Altamonte Springs, FL], Bio 2000® [Argen; San Diego, CA], Sinterkor™ [Pentron])
 - Similar to porcelain-fused-to-metal (PFM)
 - Flexural strength: equal to porcelain to metal
 - Translucency: low—equal to porcelain to metal
 - Opacity: high—equal to porcelain to metal

FACTORS TO CONSIDER

The choice of material depends to a large extent on factors unique to each patient. No single material is ideal for every case; each will have its advantages and drawbacks. For example, the porcelain-to-oxidizing metal materials are susceptible to excessive opacity, which will result in a lifeless-looking restoration and must be avoided. The feldspathic porcelain materials (veneers and jackets) of less than 0.8-mm thickness tend to give a restoration excessive translucency, which will result in a restoration that looks too gray and dark.¹ The following are some of the factors to consider when selecting materials:

COLOR OF THE TOOTH PREPARATION

If, after preparation, the underlying tooth color has a dark shade (i.e., between A5 and C10), the core of the material chosen should be opacous to mask the underlying dark color. However, an experienced technician can mask the underlying dark tooth color using porcelains with detailed color-masking techniques.

It is the dental technician's responsibility to remain educated about the latest materials and techniques; the proper function of the occlusion; and the optimal muscle position for esthetics, longevity, and comfort.

DESIGN OF THE PREPARATION

Some metal-free restorations require strict preparation techniques, such as a shoulder or a deep chamfer margin. Before selecting a material, the dental technician must consider whether the tooth structure allows margins of 1.0 mm, whether the margins are subgingival or supragingival, and so forth.

PATIENT'S MEDICAL HISTORY

The choice of material can be limited by allergies, a history of bruxism, etc.

DURABILITY OF THE MATERIAL

Regardless of how esthetic a restoration looks, it is not worth the cost to the patient or the efforts of the dentist and dental technician if it lacks durability.

Each of these factors must be considered in every case to achieve the best esthetic results. Metal-free restorations are more similar to a natural tooth than to an artificial crown. While metal-free restorations

are unlikely to replace PFM restorations, they offer alternatives for patients who demand a more natural-looking restoration. It is the dental technician's responsibility to remain educated about the latest materials and techniques; the proper function of the occlusion; and the optimal muscle position for esthetics, longevity, and comfort.

New materials are constantly being introduced by manufacturers. However, it is unwise to use materials until they have been used and tested for a number of years. Before using a new material for the first time, the dental technician must ask several questions, such as: How long has the material been available? What studies have been conducted on the material?

In addition to the material used for the understructure, the layering porcelain must be selected with equal care. A porcelain system with internal colors will achieve maximum esthetics. Today's specialized porcelains give the dental technician an advantage.

CASE REPORT

A female patient disliked the existing crown on a maxillary central incisor, which had been cemented only three years previously. She reported that she avoided smiling because of the crown's unpleasant appearance. The dentist who had placed the crown also had done a composite build-up on the mesial and incisal third of the lateral incisor. When the crown was removed, it was determined that no modification of the preparation was needed (Fig 1). Impressions were taken, and the tooth was temporized (Fig 2). Together, the dentist and the dental technician conducted a custom



Figure 1: Preparation of the central incisor. Note the slight discoloration at the incisal aspect of the preparation. Resin composite has been used to build up the mesial aspect of the lateral incisor.



Figure 2: Temporization of the central incisor.

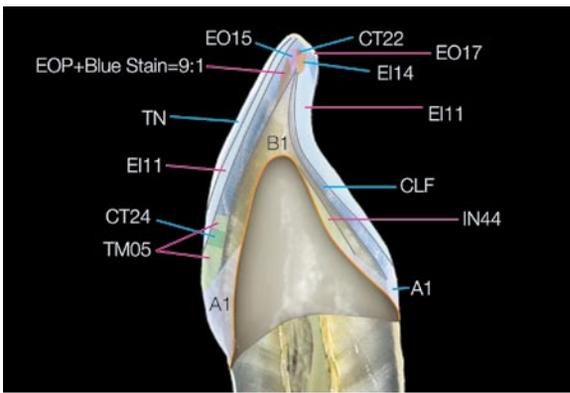


Figure 3: Color mapping using a pressed ceramic coping.²

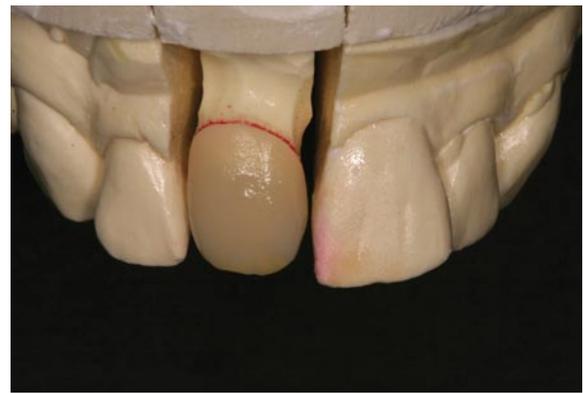


Figure 4: After evaluation of the preparation, adequate room for a pressed ceramic coping with layering porcelain technique. Shade A1 pellet with internal stain on the pressed coping. The gingival third has a gray effect and the middle third has a yellow-brown hue.



Figure 5: Sample colors of the translucent neutral, enamel opal, enamel occlusal, cervical translucent, and clear fluorescence, fabricated by the technician.

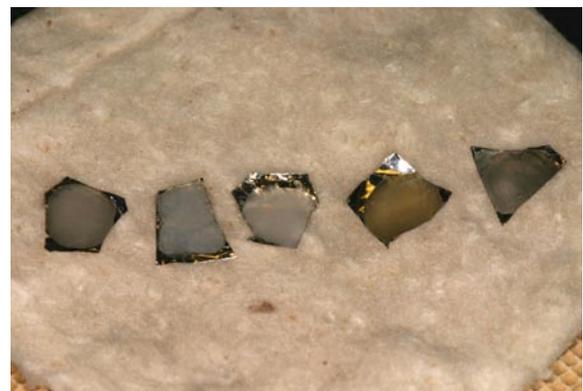


Figure 6: Sample colors after firing, made at 0.3- to 0.4-mm thickness. These have been ground and glazed to simulate a final restoration.



Figure 7: The sample color tabs are laid on top of each other to assess the different color effects.



Figure 8: Color tabs of the enamel shades.

shade mapping; afterward, the dental technician did a full color mapping (Fig 3) with the porcelain colors that are available.

SHADE MAPPING AND PHOTOGRAPHY

Comprehensive shade mapping is a time-consuming process. No single base shade can provide an adequate esthetic match. Different shades are needed in the gingival, body, and incisal thirds of the tooth, which also must be divided according to its mesial and distal characterizations. Standard shade tabs can serve as a base shade and offer a place to start; however, because of the popularity of bleaching, establishing a base shade in itself can be difficult. Moreover, because the thickness of the shade tabs does not match that of the finished restoration, some color differences must be anticipated when using these, as well.

Unfortunately, shade guides are not representative of the value of real teeth, which is another reason why relying on shade tab assessment alone can be problematic. Special shade tabs are also needed for the opalescence, fluorescence, and translucency of natural teeth. To

achieve these effects, the dental technician must make use of a porcelain system with its own effect powders and color-matching tabs and nomenclature. This can also be used to match the surface characteristics such as glaze, texture, and luster.

If light should reflect off the crown in a different manner from the neighboring teeth, it will betray the fact that it is an artificial restoration even if the shade is perfect.

If the dental technician cannot meet the patient in person, photography must be used to supplement and enhance communication with the dentist. Reference photography with shade tabs is a highly effective means of communication. Digital photographs show excellent detail with regard to colors, glaze, texture, and luster.

Master casts were fabricated. In addition to the master casts, the following information was provided:

- The preparation revealed slight discoloration at the incisal aspect.

- The preparation design offered sufficient room for the restoration.
- The patient had no known allergies, and her occlusion was not a concern.
- The patient was looking for a permanent type of restoration.³

Based on all of these factors, pressed ceramics with layering porcelain was the material selected for the restoration in this case.

PRESSED CERAMICS WITH LAYERING PORCELAIN

For the pressed ceramics, a variety of different manufacturers' ingots were selected for a wide assortment of colors, including dentin, bleached (A0, A00, B0, B00 with 75% opacity), and veneer shades; occlusal enamel light and milky; translucent ingots; and opaque ingots. The opaque ingots (with 85% opacity) are valuable for masking discolored preparations. With pressed ceramics, too much translucency can occur, so a variety of choices are needed. The opacity level of the ingots ranges from about 30% to 85%.

Once the choice of material was made, the central incisor was waxed to full contour on the cast and cut



Figure 9: Inside powder (IN 44–shade) is applied, followed by dentin A1 over the gingival to middle third.



Figure 10: Enamel intensive and cervical translucent powders are layered in a transition of color to achieve a mammelon effect. Enamel occlusal is applied to the mesial to match the composite build-up on the lateral incisor. Enamel effect is applied to the distal aspect, giving it an enamel effect.



Figure 11: Translucent neutral covers the incisal to middle third to provide translucency with neutral color, allowing the underlying colors to show through.



Figure 12: The texture and the amount of translucency together result in a varying degree of light reflection (sample fabricated by Luke S. Kahng, C.D.T.).

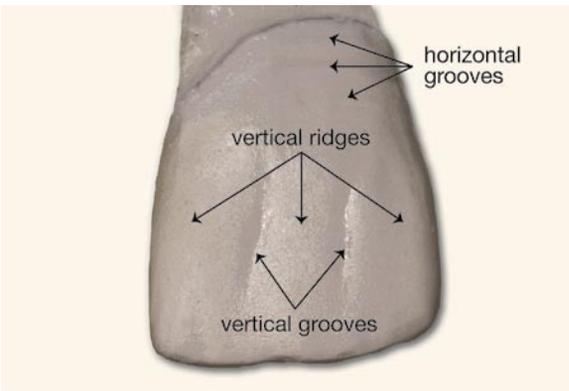


Figure 13: Surface texture characteristics coincide with those of the lateral incisor.



Figure 14: Crown is modified to give same texture of the adjacent anterior. Surface texture checked with a silver powder marker on the surface of the centrals.



Figure 15: Pressed ceramic coping with multilayered porcelain build-up.



Figure 16: View after insertion; color matching and surface texture followed (central incisor crown).

back for the porcelain layering. The wax-up was then sprued, invested, and prepared to press. After the ceramic has been pressed, care must be taken to avoid overheating it when cutting off the sprues or modifying the framework. When the cut-back framework was ready for porcelain application, the thickness was evaluated to determine the amount of room available for layering porcelain. If necessary, the shade of the framework can be modified with internal stains (Fig 4), which can be applied either on the pressed ceramic coping material or internally on the porcelain build-up, as well as externally.

The thickness of the porcelain system color-matching tabs also can be a problem. Sample colors of the translucent neutral, enamel opal, enamel occlusal, cervical translucent, and clear fluorescence were fabricated in thicknesses of 0.3 to 0.4 mm (Figs 5 & 6), then ground and glazed to represent a final restoration. The thickness of these fired porcelain discs is important; discs 0.2 mm or less will be too clear, while those at 0.6 mm will be too thick. The translucent colors should be placed on top of each other to

assess light transmission colors (Fig 7). These samples allow the dental technician to mimic the shadow zones, or areas of the restoration (Fig 8) that will lose both chroma and brilliance.

Inside powders and a specially developed, highly fluorescent primary dentin, which gives the color depth effect, were used for the first layer of porcelain (Fig 9). Dentin porcelain was applied over the gingival and middle thirds to give the crown optimal chroma (i.e., saturation or strength of hue). The color is produced by reflection from the dentin. The dentin porcelain was cut back to provide room for a mammelon effect. Enamel and enamel opal porcelain were applied to provide shade graduation similar to that of natural incisal areas as well as translucency. The enamel powder has a high level of opalescence in conjunction with high translucency to create an underlying background to the mammelon effect (Fig 10).⁴

A thin layer of clear fluorescence powder was applied between the dentin and enamels. This so-called sclerose dentin brings true-to-nature depth into the tooth color. Translucent modifiers were applied over the

clear fluorescence powder; they can be used individually or mixed with the neutral or opal translucent.

Enamel effect powders were used at the incisal area to give the natural appearance that cannot be achieved with just one enamel shade and an application of translucent, the neutral color (Fig 11). Then the enamel powder was applied to achieve full color saturation. Dentin enamel incisal and occlusal build-up was applied to the lingual of the crown. To complete the build-up at the contact areas, the crown was removed from the cast. Then it was ready for baking and firing.

SURFACE TEXTURE

Matching the surface texture is just as important as matching the shade (Fig 12). Indeed, surface texture is one of the most important elements of an esthetic restoration. The surface texture of an anterior tooth is on prominent display (Fig 13). For this reason, it will appear heavier than the neighboring teeth. If light should reflect off the crown in a different manner from the neighboring teeth, it will betray the fact that it is an artificial restoration even if the shade is perfect.



Figure 17: Lateral view to evaluate the segmentation of the color saturation.



Figure 18: Smile view showing the harmony and color saturation of the central incisors.

Surface texture can affect brightness, color saturation, luster, and so forth (Fig 14). A natural tooth does not present an absolutely smooth surface; it is generally a gently undulating surface, traversed by very fine horizontal grooves. The horizontal parallel ridges, or growth lines, and the small vertical ridges that run parallel to the marginal ridges help it to blend into the oral environment. Porcelain color build-up reveals a technician's technical ability, but the surface texture reveals a technician's esthetic touch (Fig 15).^{5,6}

The completed crown was placed on the prepared tooth (Figs 16 & 17). The patient was very pleased with the results and no longer found it necessary to hide her smile (Fig 18).

CONCLUSION

In terms of shade matching, the single central incisor can be the most difficult tooth for a dental technician to fabricate. The selection of the material for the framework is only the first step in this process. Several factors must be considered, including the design of the restoration, the patient's medical history, and the durability of the material. Once the correct material is selected,

the communication between dentist and dental technician and the dental technician's knowledge and talent are of paramount importance in achieving a natural-looking restoration and a successful esthetic result.

Acknowledgement

Case courtesy of Rick Alwan, D.D.S., Naperville, Illinois.

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